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**Citation for published version:**

Asher, N, Lascarides, A, Lemon, O, Guhe, M, Rieser, V, Muller, P, Afantenos, S, Benamara, F, Vieu, L, Denis, P, Paul, S, Keizer, S & Dégremont, C 2012, Modelling Strategic Conversation: the STAC project. in S Brown-Schmidt, J Ginzburg & S Larsson (eds), *Proceedings of SemDial 2012 (SeineDial): The 16th Workshop on the Semantics and Pragmatics of Dialogue*. pp. 145-146.

**Link:**

[Link to publication record in Edinburgh Research Explorer](#)

**Document Version:**

Peer reviewed version

**Published In:**

Proceedings of SemDial 2012 (SeineDial)

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## Modelling Strategic Conversation: the STAC project

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### Abstract

The STAC project will develop new, formal and robust models of non-cooperative conversation, drawing from ideas in linguistics, philosophy, computer science, and economics. The project brings a state of the art, linguistic theory of discourse interpretation together with new data-driven models of agent interaction and strategic decision making. Here we discuss the project's linguistic underpinnings, and the conceptual and empirical challenges the project faces. We also describe the project's current data collection activities.

- b. B: I've got lots of wheat [in fact, B has a rock]
- c. A: I'll give you 2 clay for a rock
- d. B: How about 2 clay for a wheat?
- e. A: I'll give 1 clay for 3 wheat
- f. B: OK, it's a deal.

Nevertheless, here cooperativity has not broken down entirely: (1b) supplies an (indirect) answer to (1a), and so in contrast to an assertion such as *I won't answer* it meets at least one goal that is associated with asking a question. Similarly, *A's* assertion (1e) attends to *B's* underlying goal in uttering (1d), of obtaining clay. We also note here that such dialogue contributions describe the preferences of individuals, so that modelling complex preferences will be a key feature of dialogue state representation for STAC.

### 1 Introduction

An assumption of all implemented dialogue systems and almost all formal work on discourse is that agents are fully cooperative. What this means is that agents adhere to principles such as: normally one believes what one says (e.g. (Grosz and Sidner, 1990)) and that one normally tries to help one's interlocutors achieve their goals. The latter in turn requires speakers to adopt shared intentions; in other words, their preferences are fully aligned, and they are *sincere* —they believe what they say. Consequently, all dialogue systems to date are limited to domains where such assumptions are sustainable, such as tourist information. But there are many scenarios where this level of cooperativity doesn't apply: for example, dialogues involving complex negotiations (Traum, 2008), or political debate (Lipman and Sippi, 1995). In a dialogue from the Settlers of Catan game below, (1b) is true but misleading because it implicates that *B* doesn't have rock.

- (1) a. A: Do you have rock?

### 2 Data collection: Settlers of Catan

We are currently collecting non-cooperative dialogue data using an online version of the popular board game "Settlers of Catan" (see figure 1). Negotiation dialogues are a critical part of the game, and information hiding and deception are observed in the data. The original JSettlers interface was developed by (Thomas and Hammond, 2002), and we have modified it to include a chat tool whereby players' trading dialogues are being collected (Guhe and Lascarides, 2012). An annotation scheme for non-cooperative negotiation dialogues is being developed in the project.

### 3 Project components

#### 3.1 Modelling Preferences

Just as the dynamic semantics of SDRT treats an utterance as a relation between information states, we will treat utterances as relations or transitions between preference states. These states reflect the



Figure 1: The adapted J-Settlers interface

structure and logical dependencies among the various factors that influence agent behaviour. *Conditional preference* (CP) nets (Boutilier et al., 2004) provide a computationally effective and highly compact representation for expressing and reasoning with preferences over large sets of features, and we will use this in our model. CP-nets provide an effective way to handle the fact that dialogue often reveals complex preferences, incorporating dependencies between features. STAC will determine algorithms for uncovering preferences from conversation.

### 3.2 Modeling Non-Cooperative Dialogue

Segmented Discourse Representation Theory (SDRT) has a well articulated theory of dialogue, which provides a clear and formal interaction between attributions of attitudinal states and discourse contributions (Asher and Lascarides, 2003). The dynamics of SDRT allows us to constrain agent modelling, restricting search over actions and preferences (Asher and Lascarides, 2008). However, SDRT’s cognitive logic, as detailed in (Asher and Lascarides, 2003), is a static, BDI logic that fails to reflect the structural complexity of decision problems, and it has nothing to say about less than completely cooperative and infallible agents. Work in STAC is replacing this cognitive model to address these shortcomings.

### 3.3 Statistical models and Machine Learning

We are also exploring how reinforcement learning (RL) — a statistical planning method for acquiring optimal dialogue policies (see e.g. (Rieser and Lemon, 2011)) — can be used to learn optimal *strategic* dialogue policies. A new challenge for RL is to work in non-cooperative domains

such as resource negotiation in Settlers, where an agent may not be fully honest when expressing their preferences. This type of partial observability falls outside the scope of current Partially Observable Markov Decision Process (POMDP) approaches to dialogue, which focus on uncertainty derived from speech recognition errors. Finding a suitable generalization of the POMDP framework to handle such data is an important challenge for the STAC project.

## 4 Future Work

As well as using the Settlers domain, the STAC project is also exploring data from debating dialogues (Lipman and Sippi, 1995). Please see <http://www.irit.fr/STAC/>

## Acknowledgments

The research leading to this work has received funding from the European Community (FP7/2011-16) under grant agreement no. 269427 (STAC).

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